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(54) Universal joint components

(57) A cross member for a universal joint has radially extending trunnions (14). The cylindrical bearing surfaces of the trunnions are grooved (32A) about their axes. The grooving serves to retain a supply of lubricant at the bearing surface despite the oscillatory movement of rolling bearing elements over the bearing surface. The grooving may be helical and may be randomly discontinuous. It may be achieved by a rough machining operation, optionally followed by roll burnishing, the bearing surface subsequently being heat treated.

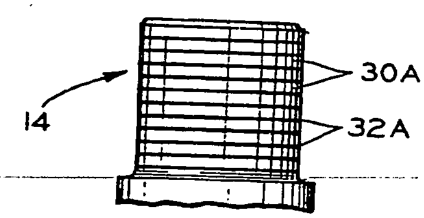

FIG. 2

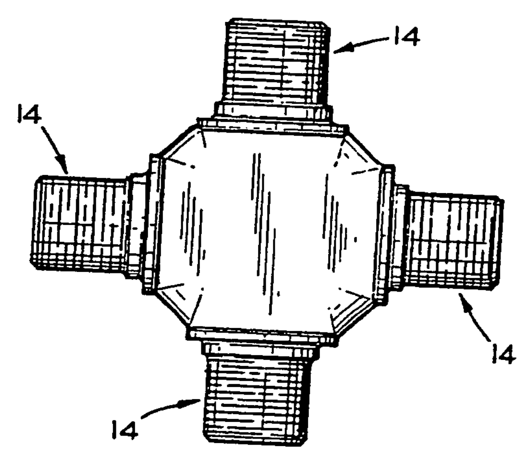

FIG. 8

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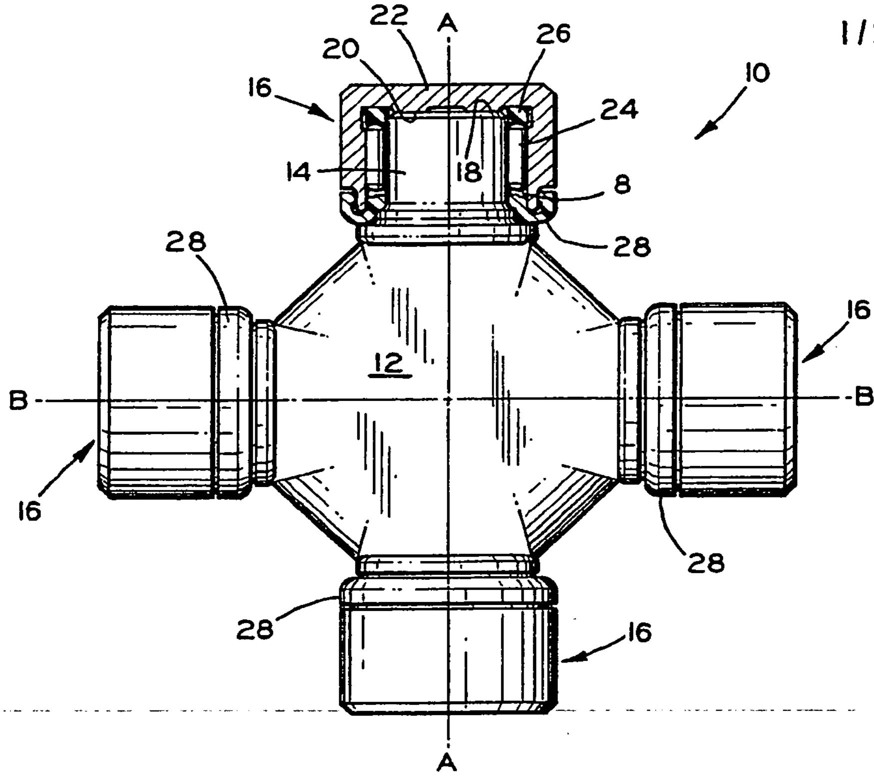

FIG. 1

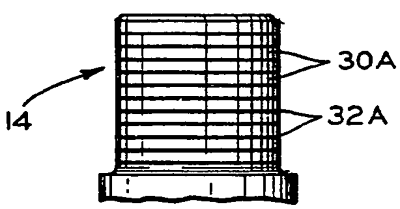

FIG. 2

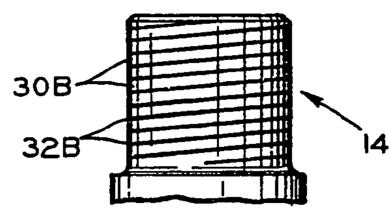

FIG. 3

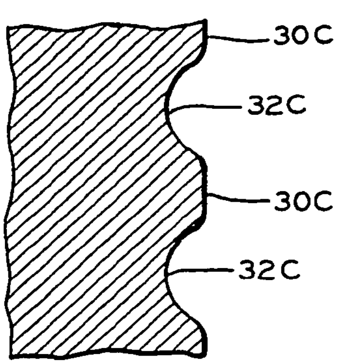

FIG. 4

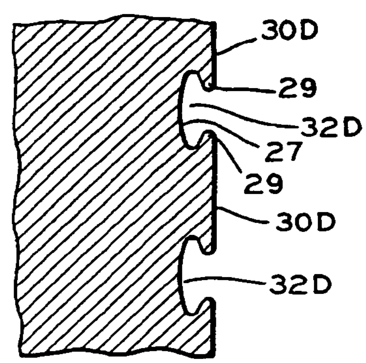

FIG. 5

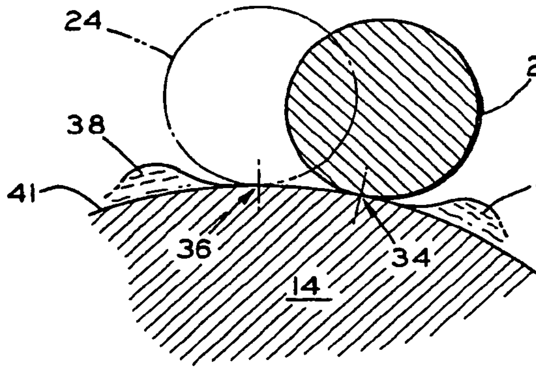

FIG. 6

PRIOR ART

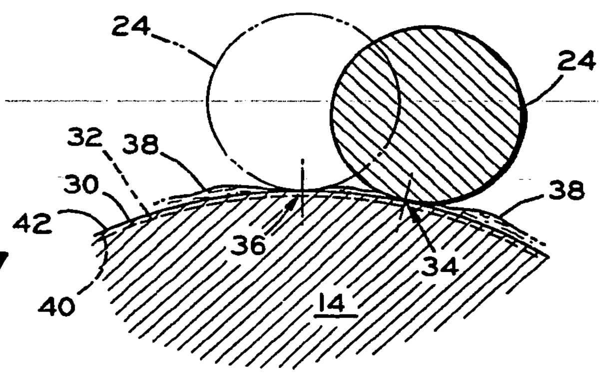

FIG. 7

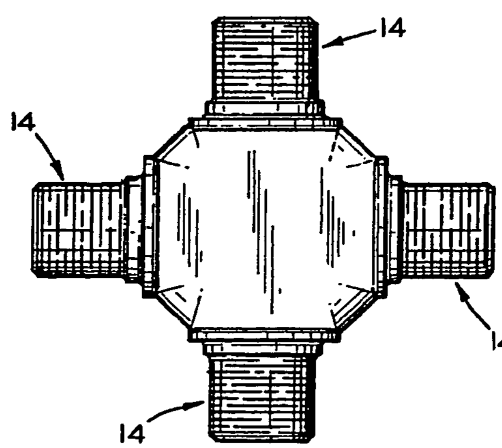

FIG. 8

SPECIFICATION
Universal joint components

This invention relates to components for universal joints of the Cardan type which comprise cross members having radially extending cylindrical trunnions for interconnecting yokes mounted respectively on two rotary members. More particularly, the invention arises from a desire to improve lubrication at the trunnion-yoke interface.

The trunnions of such assemblies may be supported in needle roller bearings which comprise needle bearing elements accomodated in bearing cups fitted into, and frictionally engaging, the limbs of the yokes. Each cup contains an annular array of the needle bearing elements which are physically interposed between the inner periphery of the cup and the associated trunnion, so that substantially frictionless movement may take place between the trunnion and the bearing cup.

Hitherto, the trunnions have been ground to highly polished finishes for rolling contact with the needle bearing elements. Such bearing systems, variously referred to as anti-friction bearings, thus have very smooth surfaces which do no satisfactorily provide for positive oil circulation during the limited oscilatory or vibratory movements of the type encountered in universal joint operation. As will be appreciated by those skilled in this art, anti-friction bearings tend to depend on continuous revolutionary movement of the bearing members for proper lubrication. Because revolutions of bearings associated with universal joints are only partial, poor oil circulation is achieved which results in relatively unsatisfactory joint performance. Moreover, in dirty and/or corrosive environments, the lack of sufficient lubrication becomes extremely critical, and can often result in premature failure of the bearing trunnion system. In moisture-laden and/or corrosive environments, fretting corrosion can also occur to accentuate wear and thereby accelerate the deterioration of the bearing-trunnion interface.

According to one aspect of the present invention there is provided a universal joint component having a bearing surface which, in use, is engaged by rolling elements of a rolling element b aring which permits angular movement of the component relatively to another component of the universal joint axis, the bearing surface being grooved about the axis.

According to another aspect of the present invention there is provided a method as just defined, the method comprising:

a) providing the grooving in the bearing surface by a machining operation; and

b) heat treating the portion of the component on which the bearing surface is provided.

Embodiments in accordance with the present invention provide improved lubrication means for anti-friction bearing trunnion systems of the type normally having smooth and/or ground countours in universal joint assemblies. A plurality of closely and/or minutely spaced lands and lubrication grooves are disposed circumferentially about each trunnion, the lands providing contact surfaces for needle bearing elements, and the grooves providing means for retention of lubricant between bearing elements and trunnion surfaces. In a preferred embodiment, the lands and grooves are uniformly and alternately spaced, respectively, each of the lands and grooves being oriented in planes generally perpendicular to the longitudinal axes of the trunnions. The lands and grooves may be partially and randomly discontinuous about the circumference of each trunnion.

Methods in accordance with the present invention include the steps of machining and heat treating, without the usual intermediate or final grinding step. The method may include roll burnishing the lands of the trunnions prior to heat treatment.

For a better understanding of the present invention, and to show how it may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:

Figure 1 is a plan view, partially in section, of a cross member assembly for a universal joint;

Figure 2 is a fragmentary view of one pattern of grooves on the trunnions of the cross-member;

Figure 3 is a fragmentary view of another pattern of grooves on the trunnions;

Figure 4 is a sectional view showing one configuration for the grooves;

Figure 5 is a sectional view showing another configuration for the grooves;

Figure 6 is a fragmentary cross-sectional view of the interface between a trunnion and a roller of a needle bearing in a prior art universal joint;

Figure 7 is a view corresponding to Figure 6 but representing a universal joint having a cross-member in accordance with the present invention; and

Figure 8 shows a cross member in which the grooves on the trunnions are arranged in an alternative pattern to those shown in Figures 2 and 3.

The cross member 10 of Figure 1 comprises four trunnions 14, each extending radially outwardly along perpendicular axes A—A or B—B of a centre body portion 12. Each trunnion 14 is received in a needle roller bearing assembly 16 comprising a plurality of needle roller elements 24 accommodated within a bearing cup 22. The cylindrical body portion of each trunnion 14 terminates at an end face 18 which abuts and slidingly engages a mating thrust surface 20 within each bearing cup 22. The bearing elements 24 are free to rotate within an annular bearing cavity 8, defined between the interior cylindrical surface of the bearing cup 22 and the exterior cylindrical surface of the trunnion 14. An elastomeric friction ring 26 is supported in each bearing cup 22 to ensure proper radial positioning of the needle roller bearings 24, as will be understood by those skilled in the art. Annular elastomeric sealing members 28 operate to protect the bearings from external dirt and other

contamination. The members 28 also aid the retention of lubricant within the bearing cavity 8.

As shown in Figures 2 to 5, each trunnion 14 is grooved to provide, as viewed in axial cross-section, alternately spaced lands 30 and grooves 32 for providing improved oil retention over the cylindrical surface of the trunnion 14. Lands 30 and grooves 32 are particularly identified with suffixes A, B, C, and D in Figures 2, 3, 4 and 5, respectively, for distinction purposes only. Figures 4 and 5 illustrate two preferred mbodiments of the lands 30 and grooves 32, respectively. In both embodiments, the grooves 32 provide passages or troughs for retaining oil for lubricating the trunnion lands 30 and the needle bearing elements 24 which roll thereon, the lands 30 defining the actual bearing roller contact surfaces between the trunnion 14 and the needle bearing elements 24. The grooves 32 of Figure 4 r present an embodiment formed by a machine tool. For example in a turning or milling operation. The groove 32 of Figure 5, however, depicts an embodiment which, although also formed by such a tool, is also given a subsequent roll burnishing operation to create a projection 29 on either side of the groove 32 which slightly overlaps the bottom 27 of the groove.

It will be appreciated by those skilled in the art that the needle bearing elements 24 do not traverse the entire periphery of the trunnion when used in a universal joint. Referring to Figure 6, it will be seen, for example, that the needle bearing 24 as shown therein will move from the position shown at 34 so that shown at 36 and back to 34 in an oscillating movement, and thus over a fairly localized surface portion of the trunnion 14. Under such movement, if the mating surfaces are smooth, as for example where they have been finely ground, the lubricant 38 will tend to be forced outwardly of the path defined between points 34 and 36, resulting in a contact area therebetween prone to becoming starved of lubrication. It is, however, well known that in most anti-friction roller bearing applications, a roller element 24 will make complete revolutions relative to the cylindrical member which it engages, so that an oil wave remains continuously in motion about the circular member. As a result, the smoothly ground surfaces in most anti-friction roller bearing environments are not as prone to localized oil starvation problems as they are in universal joints.

As this invention relates to proper lubrication under oscillatory or vibratory movement, it will be seen from Figures 2 and 3, the preferred embodiments of this invention, that the lands 30 define rolling contact surfaces for the needle b arings, and each of the lands 30 and grooves 32 ar parallel, or approximately oriented parallel, to planes perpendicular to the axes of the trunnions 14. In Figure 2, the lands and grooves 30 and 32, respectively, define individual annular paths about each of the cylindrical trunnion bodies. In the embodiment of Figure 3 however, the lands and grooves lie on helical paths about the cylindrical trunnions 14. In both instances, the preferred embodiments of each land and each groove are such that adjacent lands are separated from one another by equal distances and adjacent grooves are separated from one another by equal distances. It will be appreciated that, although reference is made for convenience to "grooves" and "lands" in the plural, it may be that, strictly, the trunnion of Figure 3 may have only a single helical groove and a single helical land.

Referring now to Figure 7, it may be more fully appreciated that the lubrication of the contact area between the trunnion 14 and the needle bearing element 24 is substantially improved between oscillation points 34 and 36 by the provision of the grooves 32. Thus, in Figure 7, the lubricant 38 will not wash away from the contact path extending between points 34 and 36, but will instead be retained within the grooves 32 between these contact points. The depth of the grooves 32 is represented by the space between the bottom of the groove 32, shown as an arc 40, and the top of the land 30, shown as an arc 42. By contrast, the smoothly ground cylindrical contact areas between both trunnion 14 and roller 24 in the prior art interface of Figure 6 will create the tendency for the lubricant to wash away from the contact path between points 34 and 36 along the smoothly ground contact arc 41 of the trunnion 14.

A preferred method of forming the lands 30 and the grooves 32 in the trunnion involves rough machining, and then heat treating the trunnions, without intermediate or final grinding and/or polishing steps. The cross members are generally metal forgings, but may alternatively comprise metal castings, as will be appreciated by those skilled in the art. The machining is preferably achieved at cutting speeds in the range of 400 to 600 revolutions per minute. The feed rates of the machine tool are preferably in the range of 15 to 20 thousandths of an inch (0.38 to 0.51 mm) per revolution. Preferred cutting depths are in the range of 60 to 90 thousandths of an inch (1.42 to 2.29 mm).

A machining operation conducted at the preferred feed rates and cutting depths herein noted will effectively achieve a roughly turned surface in a typical metallic trunnion member, as will be appreciated by those skilled in the art. In the helical embodiment of Figure 3, such a surface may be achieved by a constant tool contact over the total longitudinal axis of the trunnion body. Characteristic of the preferred machining parameters is a tendency for the tool to occasionally cut the lands 32 and the grooves 32 in a partially and randomly discontinuous manner about the circumference of each trunnion, thus exhibiting an appearance as shown in Figure 8. The discontinuities produced, however, are not disruptive of the improved lubrication featur of the invention. At this point, as was mentioned in connection with Figure 5, an optional roll burnishing step may be performed by a rolling member which penetrates the lands at a surface

depth preferably in the range of 5 to 10 thousandths of an inch (0.13 to 0.26 mm).

The preferred heat treatment step includes carburizing the trunnions in a nitrogen atmosphere at approximately 1650° to 1750°F (900 to 954°C), then quenching the trunnions in oil.

Embodiments in accordance with the invention as described herein provide a substantially improved lubrication mechanism for trunnions and associated needle roller bearings for use in universal joint assemblies. Alternative configurations are seen to fall within the appended claims, and benefits other than oil retention on the trunnion surface area are envisioned. For example, the annular grooves may also provide for retention of corrosion and other debris particles from the mating surfaces. The latter would operate to reduce deleterious effects produced by the presence of such particles along the contact interface of the rolling members. Also, for example, the lands and grooves might alternatively or in addition be formed in the interior cylindrical surface of the bearing cup 22.

CLAIMS

1. A universal joint component having a bearing surface which, in use, is engaged by rolling elements of a rolling element bearing which permits angular movement of the component r latively to another component of the universal joint axis, the bearing surface being grooved about the axis.

2. A universal joint component as claimed in claim 1 or 2, in which the bearing surface is provided with at least one helical groove.

3. A universal joint component as claimed in claim 2, in which adjacent groove turns are equally spaced from one another, in a direction parallel to the axis, and are separated from one another by land portions, adjacent land portions being equally spaced from one another in a direction parallel to the axis.

4. A universal joint component as claimed in claim 1, in which the bearing surface is provided with at least one groove which provides a closed path around the axis.

5. A universal joint component as claimed in claim 4, in which a plurality of such grooves are provided, adjacent grooves being spaced equally from one another in a direction parallel to the axis and are separated from one another by lands, adjacent lands being spaced equally from one another in a direction parallel to the axis.

6. A universal joint component as claimed in any one of claims 2 to 5, in which the or each groove is randomly discontinuous about the axis.

7. A universal joint component as claimed in any one of the preceding claims, which is a cross member having a plurality of radially extending cylindrical trunnions on each of which a said bearing surface is provided.

8. A universal joint component as claimed in any one of claims 1 to 6, which is a bearing cup having an internal cylindrical surface which comprises the bearing surface.

9. A method of making a universal joint component in accordance with any one of the preceding claims, the method comprising:

a) providing the grooving in the bearing surface by a machining operation; and

b) heat treating the portion of the component on which the bearing surface is provided.

10. A method as claimed in claim 9, in which the component is a cross member having radially extending trunnions, in which step (b) comprises heat treating the trunnions.

11. A method as claimed in claim 9 or 10, in which the bearing surface is roll burnished between step (a) and (b).

12. A method as claimed in claim 11, in which step (a) is performed with a cutting depth which is not less than 0.06 inches (1.42 mm) and not more than 0.09 inches (2.29 mm) and in which roll burnishing is achieved by a rolling member which penetrates the outer surface of the bearing surface by not less than 0.005 inches (0.13 mm) and not more than 0.01 inches (0.26 mm).

13. A method as claimed in any of claims 9 to 12, in which step (a) is performed with a cutting speed which is not less than 400 r.p.m. and not more than 0.02 inches (0.51 mm).

14. A method as claimed in any one of claims 9 to 13, in which step (b) comprises carburizing the portion of the component on which the bearing surface is provided at a temperature which is not less than 1650°F (900°C) and not more than 1750°F (954°C) and then quenching that portion in oil.

15. A method as claimed in any one of claims 9 to 14, in which step (a) comprises a rough machining operation and step (b) comprises a finishing step.

16. A cross member for a universal joint substantially as described herein with reference to, and as shown in, Figure 1 in combination with any one of Figures 2, 3 and 8 and/or in combination with Figures 4 or 5.

17. A universal joint including a component in accordance with any one of claims 1 to 8 or claim 17.

18. A method of making a universal joint component substantially as described herein with reference to the accompanying drawings.

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